

# GENERATION OF ELECTRICITY

## BACKGROUND

The production of electricity is generally referred to as generation, and is measured in kilowatt-hours. Gross generation is the amount of power produced by an electric powerplant (station), measured at the plant's terminals (that is, prior to the point at which the power leaves the station and is available to the system). Some of the electric power generated at a powerplant is used to operate equipment at the plant. Power used at the plant is generally between 1 percent (hydroelectric units) and 7 percent (steam-electric units). Net generation is the power available to the system (gross generation less use at the plant); however, it is greater than that available to consumers due to losses during transmission and distribution.

The energy sources used for producing electricity fall into two broad categories: nonrenewable (those that cannot be replaced once used) and renewable (those that are constantly replenished). The most common nonrenewable energy sources used for generation are the fossil fuels (coal, petroleum, and natural gas) and uranium. These energy sources account for more than 85 percent of the Nation's net generation. The renewable energy sources include the light or heat of the sun (solar); wind; the water in rivers, streams, or lakes (hydroelectric); heat from beneath the Earth's surface (geothermal); and organic waste (biomass) that is produced by either natural or technological processes.

The choice of generating technology and fuel used to produce electricity is of major importance to electric utilities because the goal is to provide the most cost-effective and most reliable electricity possible to consumers. A variety of factors influence the selection of technology and fuel; including the capital costs of the technology, operations and maintenance costs, environmental restrictions on the technology and use of the fuel, regulations affecting fuel use, the cost and availability of the fuel, and the availability of capacity associated with the type of fuel.

## GENERATION FROM FOSSIL FUELS

### COAL

Historically, most electricity in the United States has been generated using coal. After the Arab oil embargo of 1973, concerns over the availability of petroleum imports, increasing petroleum prices, and curtailments of natural gas made coal-fired generation even more important. In 1978, the passage of the Powerplant and Industrial Fuel Use and Natural Gas Policy Acts encouraged further use of coal by electric utilities. Although both Federal and State environmental laws and regulations exist, during the 1970's, renewed interest in environmental issues raised concerns about electric powerplant emissions, particularly from those burning coal. Bills were introduced during the 101st Congress to control acid rain or related air quality problems. Coal-fired generation continues to provide more than one-half of the Nation's total net generation of electricity. Most of the electricity production from coal is in the East North Central and South Atlantic Census Divisions, where substantial amounts of coal are mined.

## **PETROLEUM**

During the early 1970's, electric utilities used petroleum extensively to generate electricity because it was a relatively inexpensive fuel. But after the 1973 embargo by the Organization of Petroleum Exporting Countries (OPEC) on petroleum exports to the United States, petroleum prices rose sharply. Further price increases occurred in 1979 and 1980 following the Iranian revolution and subsequent reduction in Iranian petroleum exports. Consequently, during the past decade, utilities have not built large petroleum-fired steam units. In addition, many utilities have either converted steam units to coal or switched fuels where dual-fired capability exists. Most of the utilities that still rely heavily on petroleum to generate electricity are located along the eastern seaboard and in California. Because of recent declines in petroleum prices, use of petroleum-fired capability has shown a resurgence.

## **NATURAL GAS**

The demand for natural gas to heat homes and serve business and industry has historically taken priority over the demand of electric utilities under both Federal and State regulations. In the 1970's, many utilities were on occasion denied natural gas when available pipelines reached capacity in serving heating demand during the months from November to March (the peak heating season). By the middle 1970's, curtailments to electric utilities also occasionally occurred during the nonheating season as producers conserved supply in preparation for heating season demand. In the face of an attractive interstate price structure but deprived of supplies during many months of the year, utilities in the 1970's used relatively less expensive natural gas when it was available, then switched to other more expensive fuels when gas supplies were curtailed. Natural gas became more available to utilities with the passage of the Natural Gas Policy Act of 1978 and more frequent exemptions from the gas-use restrictions of the Powerplant and Industrial Fuel Use Act (Fuel Use Act) of 1978. Although lower petroleum prices during recent years have resulted in a decline in gas-fired generation, amendments to the Fuel Use Act in 1987 have created potential for additional future use of natural gas. The amendments to the Fuel Use Act in 1987 eased restrictions on the use of gas by removing a legal requirement to obtain an exemption for the construction of new gas-fired generating capability. The West South Central Census Division supplies more than half of the gas-fired generation in the country.

## **GENERATION FROM URANIUM - NUCLEAR ENERGY**

Generation from nuclear power has generally increased since the 1950's, and this trend continues. Since 1984, nuclear plants have provided the second largest share of total U.S. generation of electricity, after coal-fired plants. Although no new nuclear units have been ordered since 1978, and the units ordered after 1974 were not built, many that were under construction have either been completed and entered service or will enter service in the near future. Licensing delays, questions about radioactive waste disposal, and concern about nuclear plant safety have slowed these units from entering service and are still major obstacles to additional growth in the use of this energy source for generating electricity. Most of the nuclear-powered generation comes from the Middle Atlantic, East North Central, and South Atlantic Census Divisions, where over 60 percent of the nuclear units in the country are located.

## **GENERATION FROM RENEWABLE ENERGY**

### **HYDROELECTRIC**

Water is currently the leading renewable energy source used to generate electric power. However, hydroelectric plants can operate only where suitable waterways are available, and many of the best of these sites have already been developed. Generating electricity using water has several advantages. The major advantage is that water is a resource which is renewable. A pumped-storage hydroelectric plant offers a second advantage in that these systems use electricity produced by other generators (generally those that serve baseload requirements) to pump water from one storage area (reservoir) to another. Later this water is allowed to flow from the higher reservoir to the lower one through the generator. In this manner, the same energy source (water) is used twice. Net hydroelectric generation statistics reflected in this report are derived by deducting the generation used for pumping (in-house use) from the total (gross) hydroelectric generation. Since water is renewable, it is a source of cheap power. In addition, because there is no fuel combustion, there is little air pollution in comparison with fossil fuel plants and limited thermal pollution in comparison with nuclear plants. Like other energy sources, the use of water for generation has limitations, including environmental impacts caused by damming rivers and streams, which affects the habitats of the local plant, fish, and animal life. Nearly 70 percent of the hydroelectric power in the United States is generated in the Pacific and Rocky Mountain States.

### **GEOTHERMAL, WIND, SOLAR, ETC.**

Other renewable resources — geothermal (heat energy buried deep beneath the surface of the earth), wood, waste, wind, and the sun (solar) — are energy sources that are constantly replenished. These energy sources have received increased attention in recent years from utilities, but a limited number of such generating facilities are in use today. The major obstacles to their use are technology and cost. Currently, renewable resources (other than water) supply less than 1 percent of the Nation's electricity. Most of the electricity produced from this category is from geothermal power. Currently electric utilities operate geothermal plants in three States (California, Hawaii, and Utah). The Geysers, operated by the Pacific Gas and Electric Company, is the largest geothermal plant in the Nation. Only a few utilities operate units that produce electricity from wind and solar energy. Most of the electricity from these energy sources is produced from facilities in California. Wood and waste resources can be used to replace fossil fuels in utility boilers. To date, just a few electric generating units have been built that use wood as a primary fuel.